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ABPL:

An optical detector for the detection of very small objects comprises a first optical system defining an optical path and being operable to transmit electromagnetic radiation onto an object to be detected; a second optical system defining an optical path parallel to said optical path of said first optical system and being operable to receive said electromagnetic radiation after diffusion and reflection by said object; and a **converging lens** associated in common with said first and second optical systems and arranged such that said optical paths of said first and second optical systems are parallel to and symmetrical about the axis of said **converging lens** on one side thereof.

BSPU:

a **converging lens** associated in common with said first and second optical systems and arranged such that said optical paths of said first and second optical systems are parallel to and symmetrical about the axis of said **converging lens** on one side thereof.

DEPR:

In FIG. 1 an optical system for the transmission of electromagnetic radiation in the form of light rays comprises a light emitting diode

(LED) 1, a condenser 2, a diaphragm 3, and a lens focused on a hole 3' of the diaphragm 3.

DEPR:

An optical system for receiving light rays comprises, in the illustrated case, a lens 5 focused on a hole 6' of a diaphragm 6, behind which there is situated a light-ray detector such as a photo-transistor 7, a photo-resistor, a thermo-couple or a differential diode.

DEPR:

The principle of operation is as follows: The rays emitted by the emitting diode 1 are collected by the condenser 2 and focused on the hole 3' of the diaphragm 3. The illuminating light beam 9 is converted into a parallel beam by means of the converging lens 4, whereafter it is focused at the focus 8' of the common lens 8. When a plane surface perpendicular to the optical axis is situated exactly at the focus 8' of the common lens 8, an image of the hole 3' is materialised at 8'. This image gives rise to an observation light beam 10, which is formed of the rays reflected or diffused by the object at the focus 8'. The observation beam 10 converges on the hole 6' of the diaphragm 6 after having passed through the lenses 8 and 5. The photo-transistor behind the hole 6' collects the luminous energy of the observation beam and signals, by means of an associated electronic detection circuit, the presence of an object at the focus 8' of the common lens 8.

DEPR:

Should an object other than that to be detected interrupt the illumination beam elsewhere than at the focus 8' (either in front of or behind the focus 8'), the observation beam would then not become focused on the hole 6' of the diaphragm

6, but would pass, due to the phenomenon of parallax, onto the diaphragm 6 itself. No signal is then picked-up by the photo-transistor 7.

DEPR:

The detector is capable of detecting small bodies, that is to say its observation volume is very small. The image of the hole 3' at the focus 8' can be dimensioned by the choice of a diaphragm 3 of which the hole 3' is larger or smaller depending upon the desired sensitivity. In addition, it is not necessary for the entire image to be diffused by an object, but it is sufficient merely for a part of the image to set up the observation beam 10, the detector being capable of detecting the presence of a metal wire having a diameter of 0.1 mm to 25 cm, for example.

DEPR:

In FIG. 2, there will be seen a first optical system for the marking of the focus 8'. Its optical axis is parallel to the axis of the lens 8 and therefore also parallel to the axes of the optical system for the transmission of the infra-red rays and of the optical system for the reception of the rays. This first optical marking system comprises a photo-diode operating in the visible range, or marking photo-diode 11, a diaphragm 12 with a centered hole 12', a converging lens 13 having its focus 13' on the hole 12' and sending the image from this hole to infinity. This parallel marking beam 14 is focused at 8' by the lens 8.

DEPR:

This first marking optical system can be duplicated by a second identical system consisting of elements 15 to 18, and the focus 8' of the converging lens 8 is then indicated with precision by the superposition of

the two images of
the holes 12' and 16'.

DEPR:

A third improvement involves the practical construction of the detector. By virtue of the similarity of the optical transmission and observation systems on the one hand, and of the optical marking systems on the other hand, it is possible to envisage designing the optical detector as a whole as an assemblage of modules, as illustrated in FIGS. 1 and 2. FIG. 3 shows that in a basic element consisting of a cylinder 20 there are formed four cylindrical holes 21, 22, 23 and 24 situated with axial symmetry about the axis of the cylinder 20. Four modular elements 25, 26, 27 and 28 of tubular form are introduced therein, comprising respectively the converging lenses 4, 5, 13 or 17 and the diaphragm 3, 6, 12 or 16, of which the central hole is located at the focus of the associated lens. The modular elements 25 and 26 on the one hand, and 27 and 28 on the other hand, are identical. Also they could, strictly speaking, all be identical to one another. The diaphragms 3, 6, 12 and 16 could be made in order to permit rapid change of the aperture, by being demountable.

DEPR:

The converging lens 8 is readily interchangeable, for example by unscrewing, so that the detection distance can readily be modified. It will also be observed that the mechanical axis of the base cylinder 20 is identical with the optical axis of the lens 8. This arrangement facilitates the positioning of the detector and its aiming onto the object to be detected, especially if, in addition, the cylinder 20 is formed with grooves to enable it to be fixed and centered.

DEPR:

Let it be imagined that the object whose presence it is desired to detect is situated at a distance greater than the focal length of the detector. As the object approaches the detector, the observation light beam 10 gives rise to a luminous spot which shifts along a straight line on the diaphragm 6, intercepts the hole 6' at the instant when the object is located at the focus 8' and moves away again.

DEPR:

A two-zone receiver, in which the demarcation between the two zones is a line centered on the hole 6' and not parallel, preferably perpendicular, to the line described by the luminous spot on the diaphragm 6, also makes it possible to indicate whether the object is located in front of or behind the focus 8'. The signals of the two zones are identical when the object is exactly at the focus 8'.

DEPR:

The electronic circuit therefore makes it possible to adjust the gain and the switching threshold as a function of the conditions under which the presence detector is used. These conditions of use may vary with the detection distance given by the focal length of the lens 8, with the magnitudes of the apertures of the diaphragms of the optical illumination and observation systems, and with the nature of the object to be detected, i.e. its material, colour, surface state and dimensions, as also with the purpose for which the apparatus is employed.

CLPR:

7. An optical detector as claimed in claim 1, wherein said second optical

system comprises an electromagnetic radiation detector preceded by a **diaphragm** formed with a hole and a positive lens positioned with a focal point at said hole.

CLPR:

10. An optical detector as claimed in claim 1, wherein an assembly of modular optical systems is provided in a cylindrical base element which has a geometrical axis coincident with said axis of said **converging lens**, each of said modular optical systems comprising a positive lens, a **diaphragm** with a hole, and a support tube maintaining said hole at the focal point of the positive lens.

CLPR:

11. An optical detector as claimed in claim 1, which is operable to signal the presence or absence of an object or hole of a small size at a great distance from the detector in the vicinity of the focus of said **converging lens**.

CLPR:

12. An optical detector as claimed in claim 1, which is operable such that it does not respond to objects located between the detector and the focus of said **converging lens**.

CLPR:

14. An optical detector as claimed in claim 1 further comprising at least one marking optical system for illuminating with visible radiation the focus of said common **converging lens**.

CLPR:

20. An optical detector as recited in claim 17 wherein said marker optical system comprises visible light generating means, a **diaphragm** having a hole therein and a positive lens having a focal point at said

hole, said positive lens transmitting an image focused at said hole to said converging lens, which then forms an image of said hole at the focus of said converging lens.

CLPR:

21. An optical detector as recited in claim 17 wherein said first and second optical systems comprise first and second diaphragms, respectively, having first and second holes, respectively, and first and second lenses, respectively, said first lens collimating the electromagnetic radiation from said first hole and said second lens providing at said second hole an image of the focus of said converging lens.

CLPV:

(c) a converging lens associated in common with said first and second optical systems and arranged such that said optical paths of said first and second optical systems are parallel to and symmetrical about the axis of said converging lens on one side thereof, wherein

CLPV:

(d) said first optical system comprises means for transmitting said electromagnetic radiation to said converging lens in a parallel beam, said means for transmitting said electromagnetic radiation comprising a positive lens preceded in said first optical system by a source of said electromagnetic radiation, a condenser for collecting said electromagnetic radiation, and interchangeable diaphragms, each diaphragm having a hole of a different size whose image is transmitted by said electromagnetic radiation to the focal point of said positive lens, said hole being situated at the focus of said condenser.

CLPV:

first and second marking optical systems for illuminating with visible radiation the focus of said converging lens associated in common with said first and second optical systems, the optical axis of said first and second marking optical systems being both parallel to the axis of said converging lens and to the optical axis of said first and second optical systems, wherein said first and second marking optical systems each include:

CLPV:

(c) a converging lens associated in common with said first and second optical systems and arranged such that said optical paths of said first and second optical systems are parallel to and symmetric about the axis of said converging lens on one side thereof, wherein

CLPV:

(c) a converging lens associated in common with said first and second optical systems and arranged such that said optical paths of said first and second optical systems are parallel to and symmetrical about the axis of said converging lens on one side thereof; and

CLPV:

(d) at least one marking optical system for illuminating the focus of said converging lens.

CLPV:

said converging lens is further associated with said marking optical system.

CLPW:

(2) a diaphragm with a centered hole, and

CLPW:

(3) a positive lens having a focal point centered at said hole of said diaphragm, said positive lens sending the image from this centered hole through

a parallel marking beam to said converging lens, thereby allowing the focal point of the converging lens to be indicated by superposition of the image of the centered holes of said diaphragms.

CLPW:

(i) means for transmitting said electromagnetic radiation to said converging lens in a parallel beam,

CLPW:

(ii) said means including interchangeable diaphragms each having a hole of a particular size whose image is transmitted by said electromagnetic radiation to the focus of said converging lens, for providing changeable sensitivity for said detector, whereby a desired sensitivity is provided for the detection of corresponding objects of small volume.